FAQ – Submerged Arc Welding

1.What is Submerged Arc Welding (SAW)?

Submerged Arc Welding is a welding process where an electric arc forms between a continuously feeding electrode and the workpiece. The welding arc is submerged under a blanket of granular flux, which protects the arc & molten metal from contamination and helps to stabilize the arc.

2.What are the main components of the SAW process?

A) Welding Consumables

1. **Electrode**: A continuously fed, consumable wire that serves as the welding material available in spool form.
2. **Flux**: A granular substance that covers the weld area to protect it from atmospheric contamination and improve weld quality.

B) Welding Machine

1. **Power Source**: Converts the industrial supply voltage & current into the necessary electrical energy for the welding process.
2. **Welding Torch**: Feeds the electrode and flux to the weld Zone.
3. **Flux recollecting unit** : It will recollect the unused flux.
4. **Trolley / Column & Boom** : Used to positioning the welding torch

3.What are the advantages of SAW?

1. High Deposition Rate
2. Good Weld Quality
3. Reduced Fume and Radiation
4. Automation

4.What are the limitations of SAW?

1. Limited weld Positioning
2. Initial Setup Cost
3. Not Suitable for Thin Materials

5.How does SAW compare to other welding processes?

Compared to processes like MIG (Metal Inert Gas) or TIG (Tungsten Inert Gas) welding, SAW offers higher deposition rates and is more suitable for thick sections and large-scale production. However, MIG and TIG are more versatile for welding in various positions and are better suited for thinner materials.

6.What safety precautions should be taken during SAW?

1. **Protective Gear**: Use appropriate protective clothing, welding helmets, and gloves to shield against UV radiation and heat.

2. **Ventilation**: Ensure adequate ventilation to disperse welding fumes and gases.
3. **Fire Safety**: Keep the work area clear of flammable materials and have fire extinguishing equipment on hand.

7.How do you maintain SAW equipment?

1. **Regular Inspection**: Check for wear and tear on the electrode feed mechanism and other components.
2. **Flux Handling**: Ensure the flux is dry and free from contaminants.
3. **Clean Equipment**: Regularly clean the torch and other parts to prevent buildup of residue.

8.Can SAW be used in outdoor environments?

While SAW is generally used in controlled environments like workshops, it can be adapted for outdoor use with appropriate shielding and equipment to protect the flux and weld area from wind and contaminants.

9.What are some common applications of SAW?

SAW is often used in heavy industry applications, including:

- Pressure vessels & Boilers construction
- Wind mill construction
- Construction of pipelines
- Shipbuilding
- Fabrication of large structures like bridges
- Manufacturing of large-scale industrial equipment

10.What types of joints are commonly welded using SAW?

SAW is suitable for a variety of joint configurations, including:

- **Butt Joints**: Common for welding two pieces of metal end-to-end.
- **Fillet Joints**: Used to join two pieces at an angle.
- **Corner Joints**: Where two pieces meet at a corner.

11.Can SAW be used for repair work?

SAW is generally used for new construction and large-scale production rather than for repair work. The high heat input and large-scale setup can make it less suitable for small, localized repairs.

12.Are there any recent advancements in SAW technology?

Recent advancements include:

- **Automated Systems**: Enhanced automation and robotics for increased precision and efficiency.

- **Multi Wire system:** Twin wire system, Tandem & Multi wire welding systems.
- **Process variants :** Electro slag welding, Electro slag strip cladding & Submerge arc strip cladding.

13.Can SAW be used for thin materials or sheet metal?

SAW is generally not ideal for very thin materials due to the high heat input and potential for burn-through. For thin materials, processes like MIG or TIG welding are often preferred.

14.What are the typical settings for SAW?

Settings vary based on the specific application, but common parameters include:

- **Voltage**: Typically in the range of 20-40 volts.
- **Current**: Generally in the range of 200-1000 amperes.
- **Travel Speed**: Adjusted based on the required deposition rate and weld profile. Generally in the range of 250-600 mm/Min
- **Stickout Distance**: Typically 8 – 11 times of wire diameter.

15.What is the impact of welding parameters on the SAW process?

Welding parameters significantly impact the weld quality and performance:

- **Voltage**: Affects arc length and heat input. Higher voltage can lead to broader welds.
- **Current**: Influences the deposition rate and weld bead shape. Higher current increases the deposition rate but can also lead to more heat input.
- **Travel Speed**: Affects the weld bead appearance and penetration. Faster speeds can lead to incomplete fusion, while slower speeds can cause excessive buildup.

16.How does the welding position affect SAW usage?

SAW is predominantly used in the flat and horizontal positions due to the nature of the process and the flux coverage. Welding in vertical or overhead positions is challenging and generally not practical with SAW, as it requires special equipment or adaptations.

17.What are the different types of SAW machines and systems?

SAW machines come in various configurations, including:

- **Manual SAW Machines**: For less frequent or smaller-scale applications.
- **Semiautomatic SAW Systems**: Provide some automation features like automatic wire feed but still require manual positioning.
- **Automatic SAW Systems**: Fully automated with advanced controls for high-volume production and precision.
- **Robotic SAW Systems**: Integrated with robotic arms for high-speed, high-precision welding in complex geometries.

18.What are the key differences between SAW and Gas Metal Arc Welding (GMAW)?

- **Shielding**: SAW uses a granular flux, while GMAW uses a shielding gas. SAW provides a more stable arc and less fume but requires proper flux handling.
- **Application**: SAW is more suited for heavy, thick materials and large-scale production, whereas GMAW is versatile for thinner materials and various positions.
- **Deposition Rate**: SAW typically offers a higher deposition rate compared to GMAW.

19.Can SAW be used in combination with other welding processes?

Yes, SAW can be used in combination with other processes, such as:

- **Pre-Weld or Post-Weld Processes**: Combining SAW with processes like TIG or MIG for root passes or final finishing.
- **Hybrid Welding**: Integrating SAW with laser or plasma arc welding to enhance productivity and weld quality for specific applications.

20.What types of electrodes are used in SAW?

SAW electrodes are typically made of wire and can be classified into several types based on their composition and intended use:

- **Solid Electrodes**: Made of a single solid material.
- **Flux / Metal Cored Electrodes**: Contain a flux / Metal core that provides additional chemical & Mechanical properties or improves arc stability.

21.What materials can be welded with SAW?

SAW is commonly used for welding carbon steels, low-alloy steels, stainless steels & Nickel alloys.

22.How do you select the right flux for a specific application?

Choosing the appropriate flux depends on factors such as:

- **Base Material**: The type of material or alloy being welded.
- **Desired Properties**: Mechanical properties and chemical composition of the weld.
- **Welding Application:** Depends on welding travel speed & Slag removal condition.

23.How does the flux affect the weld quality?

The flux plays a crucial role in:

- **Protecting the Weld Pool**: Preventing contamination from atmospheric gases.
- **Cleaning the Weld Metal**: Removing oxides and impurities from the base material.
- **Enhancing Mechanical Properties**: Adding alloying elements that affect strength and toughness.

24.What is the role of preheat and post-weld heat treatment in SAW?

- **Preheat**: May be required to reduce thermal stress and prevent cracking in high-carbon or high-alloy steels. It helps in achieving better weld quality and reduces the risk of cold cracking.
- **Post-Weld Heat Treatment**: Can be used to relieve stresses, improve mechanical properties, and reduce hardness in the heat-affected zone, especially for high-strength materials.

25.How do you handle and store flux for SAW?

- **Handling**: Use clean, dry tools to prevent contamination. Avoid exposing flux to moisture, which can affect its performance.
- **Storage**: Store flux in a dry condition to prevent exposure to moisture and contaminants. Follow manufacturer guidelines for shelf life and usage.

26.How are saw fluxes classified?

- **Manufacturing Process:** Agglomerated & Fused Fluxes
- **Basicity Index:** Acidic & Basic
- **Chemical Activity:** Active & Neutral
- **Chemical content in flux:** Aluminate Rutile, Calcium silicate & Fluoride Basic

27.What is basicity index?

Ratio of sum of basic components to sum of acidic components in the flux

28.Significance of Basicity Index?

High Basic fluxes having B.I above 1.2 will provide low impurity weldmetal & retain the impact toughness at Subzero temperature

29.What is wall neutrality Number?

It was used to define the chemical activity of flux depends up on welding parameters. If the wall neutrality number is higher than 35, then flux consider as active & lesser than 35, flux consider as Neutral.

30. For Low temperature toughness of Creep applications, which fluxes are suitable?

High Basic fluxes are suitable with least phosphorous addition for better X factor control.

31. What is the meaning of EL8, EM12K, EH12K?

First digit (E) – Electrode

Second Digit(L,M,H) - Manganese level (L – Low, M-Medium, H- High)

Third Digit or Number – Approximate Carbon content in wire

Fourth Digit (K) - Silicon killed steel

32. What is the meaning of F7A8-EH12K?

Flux will produce the weldmetal contain 70 KSI UTS in room temperature & 27 J of impact toughness at -80°F (-62°C) at as weld condition with EH12K wire.

33. What is the meaning of F7P8-EH12K?

Flux will produce the weldmetal contain 70 KSI UTS in room temperature & 27 J of impact toughness at -80°F (-62°C) after PWHT at 620°C for 1 Hour with EH12K wire.

34. What was the effect of PWHT in the C-Mn Steel weldmetal?

After PWHT weldmetal YS & UTS dropdown 50 -80 MPa from its as weld condition & Ductility, Impact toughness will improve.

35. 1hr PWHT & 15 Hr PWHT holding time have same effect?

It depends up on chemical composition of the weld. To be verify with the consumable manufacturer.

36.SAW fluxes are available for Hardfacing applications?

Yes, available. Mostly alloyed flux used with C – Mn Steel wires.

37. What is the meaning of Redrying the flux? What is the use of it?

SAW flux to be heat to the temperature of 300 - 350°C & hold for 2 Hours before use. It used to remove the moisture from flux & provide low hydrogen weld metal.

38. if flux not used immediately after 2 Hours holding at redrying temperature, Which temperature we have to maintain?

After redrying holding time of 2Hrs, we can maintain the flux at 100°C before use. Record to be maintain for storage.

39. One flux can be use with different wires?

Yes possible, But with different wires weldmetal mechanical properties will change. So, before changing wire grade, check with manufacturer about the suitability.

40. What is the purpose of the usage of composite wire in SAW process?

In composite wire, we can add alloying elements which can improve properties & Weld chemistry is constant with irrespective to welding parameters, if neutral flux used.

If alloying elements added in the SAW flux, depend on welding parameters, weld chemistry & properties will change.

41. What are the AWS / ASME standards related to SAW Welding Consumables?

1. **AWS A5.17/A5.17M: SPECIFICATION FOR CARBON STEEL ELECTRODES AND FLUXES FOR SUBMERGED ARC WELDING**
    - **Description**: This specification prescribes requirements for the classification of carbon steel electrodes (both solid and composite) and flux-electrode combinations for submerged arc welding.
2. **AWS A5.23/A5.23M: SPECIFICATION FOR LOW-ALLOY AND HIGH MANGANESE STEEL ELECTRODES AND FLUXES FOR SUBMERGED ARC WELDING**

- **Description**: This specification prescribes requirements for the classification of solid and composite carbon steel, low-alloy steel, *and high manganese* steel electrodes and flux-electrode combinations for submerged arc welding (SAW). This specification covers low-alloy *and high manganese* electrodes and low-alloy *and high manganese* multiple-pass flux-electrode classifications. This specification also addresses carbon steel, low-alloy steel, *and high manganese* steel two-run flux electrode classifications.

3. **AWS A5.23/A5.23M: SPECIFICATION FOR FLUX AND ELECTRODE COMBINATIONS FOR SUBMERGED ARC ANDELECTROSLAG JOINING AND SURFACING OF STAINLESS STEEL AND NICKEL ALLOYS**

- **Description**: This specification prescribes requirements for the classification of flux-electrode combinations using submerged arc or electroslag welding. Flux-electrode joining classifications include requirements for soundness, mechanical properties and weld metal composition. Flux-electrode cladding classifications include requirements for soundness and weld metal composition. Electrode classification is per AWS A5.9/A5.9M for solid and stranded stainless steel electrodes, A5.14/ A5.14M for solid and stranded nickel-alloy electrodes, A5.22/A5.22M for cored stainless steel electrodes and A5.34/ A5.34M for cored nickel-alloy electrodes.

42. What are the AWS / ASME standards related to SAW Welding Consumables?

1. **ISO 14174:2019: Welding consumables — Fluxes for submerged arc welding and electroslag welding — Classification**

   Description: This document specifies requirements for classification of fluxes for submerged arc welding and electroslag welding for joining and overlay welding using wire electrodes, tubular cored electrodes, and strip electrodes.

2. **ISO 14171:2016: Welding consumables — Solid wire electrodes, tubular cored electrodes and electrode/flux combinations for submerged arc welding of non alloy and fine grain steels — Classification**

   Description: specifies the requirements for the classification of electrode/flux combinations and weld metal in the as-welded condition and in the post-weld heat-treated condition for submerged arc welding of non-alloy and fine grain steels with minimum yield strength of up to 500 MPa or a minimum tensile strength of up to 570 MPa. One flux can be classified with different solid wire electrodes and tubular cored electrodes. The solid wire electrode is also classified separately based on chemical composition.

3. **ISO 26304:2017: Welding consumables — Solid wire electrodes, tubular cored electrodes and electrode-flux combinations for submerged arc welding of high strength steels — Classification**

   Description: ISO 26304:2017 specifies requirements for classification of solid wire electrodes, tubular cored electrodes, and electrode-flux combinations (the all-weld metal deposits) in the as-welded condition and in the post-weld heat-treated condition for submerged arc welding of high strength steels with a minimum yield strength greater than 500 MPa or a minimum tensile strength greater than 570 MPa. One flux can be tested and classified with different electrodes. One electrode can be tested and classified with different fluxes. The solid wire electrode is also classified separately based on its chemical composition

4. **ISO 24598:2019: Welding consumables — Solid wire electrodes, tubular cored electrodes and electrode-flux combinations for submerged arc welding of creep-resisting steels — Classification**

   Description: This document specifies requirements for classification of solid wire electrodes, tubular cored electrodes and electrode/flux combinations (all-weld metal deposits) for submerged arc welding of creep resisting and low-alloy elevated-temperature application steels. One electrode can be tested and classified with different fluxes. The solid wire electrode is also classified separately based on its chemical composition.

5. **ISO 14343:2017: Welding consumables — Wire electrodes, strip electrodes, wires and rods for arc welding of stainless and heat resisting steels — Classification**

   Description: ISO 14343:2017 specifies requirements for classification of wire electrodes, strip electrodes, wires and rods for gas-shielded metal arc welding, gas tungsten arc welding, plasma arc welding, submerged arc welding, electroslag welding and laser beam welding of stainless and heat-resisting steels. The classification of the wire electrodes, strip electrodes, wires and rods is based upon their chemical composition.

6. **ISO 18274:2023: Welding consumables — Solid wire electrodes, solid strip electrodes, solid wires and solid rods for fusion welding of nickel and nickel alloys — Classification**

   Description: This document specifies requirements for classification of solid wire electrodes, solid strip electrodes, solid wires and solid rods for fusion welding of nickel and nickel alloys. The classification of the solid wire electrodes, solid strip electrodes, solid wires and solid rods is based on their chemical composition. It includes those compositions in which the nickel content exceeds that of any other element.

7. **ISO 15792-1:2020: Preparation of all-weld metal test pieces and specimens in steel, nickel and nickel alloys**

   Description: This document specifies the preparation of test pieces and specimens for all-weld metal tests in steel, nickel and nickel alloys.The test pieces and specimens are used to determine the mechanical properties of all-weld metal where required by consumable classification standards or for other purposes, in arc welding of steel, nickel and nickel alloys.

43. Change in AWS Classification of wire & flux combination F7A4-EM12K is essential variable as per ASME Sec IX for Submerged arc welding?

Yes, Change in AWS classification is the essential variable as per ASME Sec IX.

44. Change in wire & flux trade name is essential variable as per ASME Sec IX for Submerged arc welding?

Yes, A change in either the flux trade name or wire trade name when neither the flux nor the wire is classified in Section II, Part C.

45. SAW Related Welding Defects & remedies

1. Porosity

Description: Porosity refers to the presence of small gas bubbles trapped in the weld metal, leading to a porous and weakened weld.

Causes:

- Contaminated flux or electrode
- Insufficient flux coverage
- Excessive moisture in flux
- Poor cleaning of the base metal
- Narrow Groove angle
- Excess Voltage or Low travel speed

Remedies:

- Ensure the flux and electrode are clean and dry before use.
- Maintain proper flux coverage over the weld.
- Clean the base metal thoroughly to remove rust, oil, and other contaminants.
- Use appropriate flux handling and storage procedures.
- Make wider groove angle
- Use Optimum voltage & Travel speed

2. Slag Inclusion

Description: Slag inclusions are non-metallic solid materials trapped within the weld metal, which can cause weakness and reduce the weld's overall strength.

Causes:

- Inadequate flux removal between weld passes
- Incorrect welding parameters
- Poor joint fit-up

Remedies:

- Ensure complete removal of slag between weld passes.
- Use correct welding parameters as specified in the WPS.

- Maintain proper joint fit-up and cleanliness.

3. Lack of Fusion

Description: Lack of fusion occurs when the weld metal does not adequately bond with the base metal or previous weld layers, leading to weak welds.

Causes:

- Insufficient heat input
- Incorrect welding parameters
- Poor joint preparation

Remedies:

- Adjust welding parameters to provide adequate heat input.
- Ensure proper joint preparation and fit-up.
- Verify that the welding technique and parameters align with the WPS.

4. Undercutting

Description: Undercutting is the removal of base metal along the edges of the weld, resulting in a groove that weakens the weld area.

Causes:

- Excessive welding Voltage
- Incorrect electrode angle
- High travel speed

Remedies:

- Adjust welding voltage to avoid excessive heat input.
- Ensure the correct electrode angle and maintain a consistent travel speed.
- Regularly inspect and adjust parameters to prevent undercutting.

5. Cracking

Description: Cracking can occur in various forms, such as hot cracking or cold cracking, and compromises the weld's integrity.

Causes:

- High heat input leading to excessive thermal stresses
- Rapid cooling or improper heat treatment
- Incompatible filler materials or base metals

Remedies:

- Control heat input to avoid excessive thermal stresses.

- Implement proper preheat and post-weld heat treatment as needed.
- Use compatible filler materials and base metals as specified in the WPS.

6. Overlapping

Description: Overlapping occurs when weld metal flows over the base metal without proper fusion, resulting in a weak, uneven surface.

Causes:

- Incorrect welding speed or technique
- Excessive heat input

Remedies:

- Adjust welding speed and technique to ensure proper fusion.
- Control heat input to prevent excessive weld metal from flowing over the base metal.

7. Inconsistent Bead Appearance

Description: Inconsistent bead appearance, such as uneven bead size or shape, can indicate issues with the welding process.

Causes:

- Fluctuating welding parameters
- Inconsistent welding technique
- Equipment issues

Remedies:

- Maintain consistent welding parameters as specified in the WPS.
- Ensure that welders use consistent techniques and follow best practices.
- Regularly check and maintain welding equipment to ensure proper operation.

8. Underfill

Description: Underfill occurs when the weld metal does not fill the joint completely, leaving a depression or gap.

Causes:

- Insufficient weld metal deposition
- Incorrect travel speed or welding parameters

Remedies:

- Adjust welding parameters to increase the deposition rate.
- Ensure proper joint fit-up and alignment to avoid gaps.